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Probability Notes Part 3 - Combinations and Permutations

VOCAB:

A _____ event consists of _____ or more simple events, such as a rolled number cube landing with 3 showing and a tossed coin landing heads up. (A simple event has only one outcome, such as rolling a 3 on a number cube.) For some compound events, the order in which the simple events occur is important.

A _____ is a grouping of outcomes in which the order **does <u>NOT</u>** matter. Some real world examples of this include: peanut butter and jelly sandwiches, making a group of 4 people

A _____ is an arrangement of outcomes in which the order **does** matter. Some real world examples of this include: Phone numbers, License Plates, words

Idea 1: Finding Combinations and Permutations

Tell whether each situation involves combinations or permutations. Then give the number of possible outcomes.

1a. A street vendor sells cashews, peanuts, and almonds. How many different ways are there to mix two kinds of nuts?

Does Order Matter? _____ **Circle one:** Combination or Permutation

Number of Different Ways: _____

1b. Karen is painting her bedroom. She has orange, green, blue, and purple paint. She plans to use one color as a base coat and stencil a design with another color. How many different ways can she do this?

Does Order Matter? _____ **Circle one:** Combination or Permutation

Number of Different Ways: _____

Are there more possible outcomes with a combination or with a permutation? Why? _____

_____

_____

_____

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You Try!

Tell whether each situation involves combinations or permutations. Then give the number of possible outcomes.

2a. Ingrid is stringing three different types of beads on a bracelet. How many ways can she use one bead of each type to string the next three beads?

2b. Nathan wants to order a sandwich with two of the following ingredients: mushroom, eggplant, tomato, and avocado. How many different sandwiches can Nathan choose?

2c. An English test contains 5 different essay questions labeled A, B, C, D, and E. You are supposed to choose 2 to answer. How many different ways are there to do this?

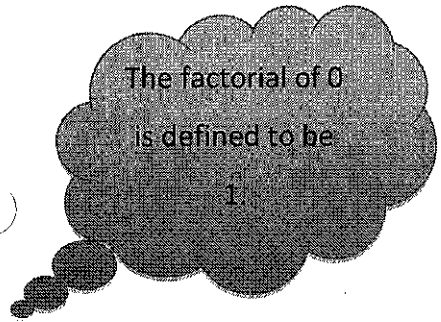
2d. A family of 3 plans to sit in the same row at a movie theater. How many ways can the family be seated in 3 seats?

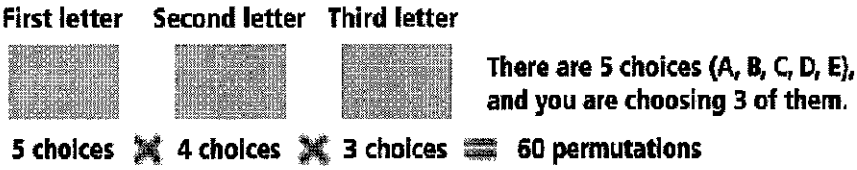
Idea 2: The Factorial

But that method is so annoying and inefficient! That's why mathematicians invented the factorial!

The factorial of a number is the product of the number and all the natural numbers less than the number. The factorial of 5 is written 5! and is read "five factorial." $5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$. Factorials can be used to find the number of combinations and permutations that can be made from a set of choices.

Suppose you want to make a three-letter password from the 5 letters A, B, C, D, and E without repeating a letter. You have one fewer choice for each letter of the password.





The number of permutations is $\frac{5!}{2!}$, or $\frac{5 \cdot 4 \cdot 3 \cdot \cancel{2} \cdot \cancel{1}}{\cancel{2} \cdot \cancel{1}} = 5 \cdot 4 \cdot 3 = 60$.

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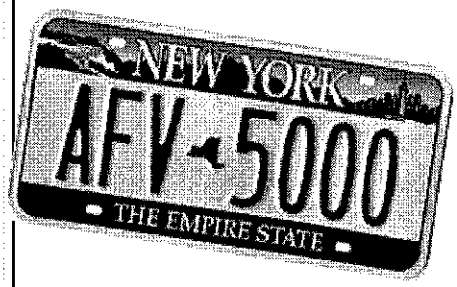
Idea 3: Finding Permutations

Permutations

FORMULA	The number of permutations of n things chosen r at a time: $${}_nP_r = \frac{n!}{(n-r)!}.$$
EXAMPLE	A club will choose a president, a vice president, and a secretary from a list of 8 people. How many ways can the club choose the 3 officers? The position that each person takes matters, so this situation involves permutations. Think: There are 8 people, and the club will choose 3 of them. $${}_8P_3 = \frac{8!}{(8-3)!} = \frac{8!}{5!} = 336$$

ORDER MATTERS!

Permutations are an ordered combination



Example 1: Lee brings 7 CDs numbered 1–7 to a party. How many different ways can he choose the first 4 CDs to play?

Method 1: Use the formula

Does order matter? _____

How many "elements" are there total (n)? _____

How many "elements" will be chosen (r)? _____

Method 2: Use the ${}_nP_r$ function on your calculator

You Try!

How many different ways can 9 people line up for a picture?

A group of 8 swimmers are swimming in a race. Prizes are given for first, second, and third place. How many different out- comes can there be?

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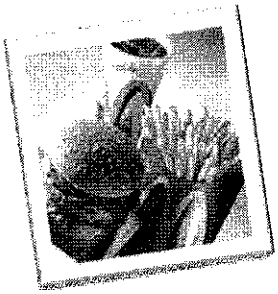
Idea 4: Finding Combinations

There are 11 different cereals for sale at a grocery store. How many different ways can a shopper select 4 different cereals?

ORDER DOES NOT MATTER!

Combinations

FORMULA	The number of combinations of n things chosen r at a time: $${}_nC_r = \frac{n!}{r!(n-r)!}$$
EXAMPLE	A club will form a 3-person committee from a list of 8 people. How many ways can the club choose the 3 people? The position that each person takes does not matter, so this situation involves combinations. Think: There are 8 people, and the club will choose 3 of them. $${}_8C_3 = \frac{8!}{3!(8-3)!} = \frac{8!}{3!5!} = 56$$



You Try!

Method 1: Use the formula

Does order matter? _____

How many "elements" are there total (n)? _____

How many "elements" will be chosen (r)? _____

Method 2: Use the ${}_nC_r$ function on your calculator

A basketball team has 12 members who can play any position. How many different ways can the coach choose 5 starting players?

Four people need to be selected from a class of 15 to help clean up the campus. How many different ways can the 4 people be chosen?

Analyze:

Is (2!)(3!) the same as 6! ? Why or why not?